



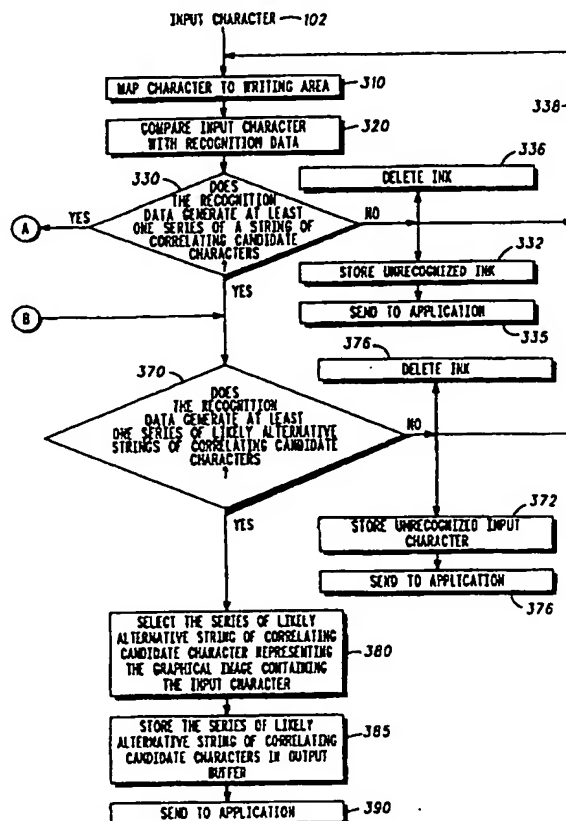
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(54) Title: METHOD AND APPARATUS FOR CHARACTER RECOGNITION INTERFACE

(57) Abstract

A method and apparatus for character recognition interface is disclosed where input data (102) received from a writing area of a display (210) is compared with character recognition data (220). At least one likely candidate character representing a word likely to represent the input data is generated (230) and displayed (240). In a preferred embodiment, at least one candidate character representing an alternative word likely to represent the input data is generated and displayed (225). At least one series of correlating candidate characters for the at least one likely candidate character and for each alternative candidate character is generated and displayed (370). Each series of correlating candidate characters represents a series of correlating words likely to include a word representing the input data. The likely displaying candidate character is displayed in an output buffer area (385) of the display. Each alternative candidate character is displayed in a candidate list area of the display. Each character displayed can be stored in a memory.



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METHOD AND APPARATUS FOR CHARACTER RECOGNITION INTERFACE

Field of the Invention

5 This invention relates generally to data input interfaces, and more particularly to character recognition interfaces of large characters sets where each character includes one or more strokes.

Background of the Invention

10 Machine recognition of human handwriting is a very difficult problem, and with the recent explosion of pen-based computing and electronic devices, has become an important problem to be addressed. There exists various different computing and electronic devices that accept handwritten input. So called pen-based products, for example, computers, and personal digital assistants, and the like typically have a touch sensitive screen upon which a user can impose handwriting. 15 These devices then function to digitize the handwritten input. Other devices, such as computers, advanced telephones, digital televisions, and other information processing devices, include or can access a digitizing tablet which can accept handwritten input. Still other devices can receive handwritten character 20 input by means of a fax, scanned input, electronic mail, or other electronic transmission of data. These devices process the information and attempt to recognize the information content of the handwritten input; typically, the device then displays that information to the user for purposes of feedback, correction of errors in the processing, and for recognition of the handwritten character input. 25 30

There exists various approaches for recognition of handwritten input when the recognition is for characters sets having a limited finite number of characters, typically under a 35

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hundred. However often such approaches do not work as well for character sets having large numbers of varied complex characters. Examples of large character sets that have been difficult to quickly and accurately recognize through
5 recognition of handwritten input are several of the Asian ideographic character/symbol languages, such as Chinese, simplified and traditional, Japanese, and other languages having large character sets. Some languages such as simplified Chinese consist of several thousand characters.

10 Traditional interface methods, such as keyboard entry, of inputting data and text supplied in one of these types of large character based languages is often very difficult; in part because of the large number and complexity of the character set. Additionally, many of these languages resort to phonetic
15 based representations using Western characters in order to enter the characters with a keyboard. Hence, keyboard-type entry of such characters is difficult. An example of the difficulty of keyboard entry for a large character set based language is keyboard entry of the Chinese language. To enter
20 data, or text, in Chinese, via a keyboard, the language is first Romanized. Western Characters, such as the English anglo-saxon alphabet, are used to phonetically represent the characters of the Chinese language. This is referred to as Pin-yin. Therefore, for a person wishing to enter data or text in
25 Chinese through a keyboard, the person must first know Pin-yin, and the corresponding English character representation for the phonetic equivalent of the Chinese character they are trying to enter via the keyboard.

Another, difficulty encountered with traditional keyboard
30 interface input for recognition of handwritten input of data, or text, based upon a language having a large character set is many of these languages have one or more forms of representing the same character, i.e., similar to print and cursive forms for the English angle-saxon alphabet.
35 Additionally, such languages may have homophones for

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example, the Chinese language has numerous homophones - words that are pronounced the same but have different meaning and written forms. Hence, the same Pin-yin can refer to a multiplicity of characters and the person entering Chinese character data must often select from a list of possible choices.

Typically, interface techniques used for data input of limited finite character sets of under hundred, do not produce accurate results for languages having large character sets, of several hundred or several thousand varied complex characters. Many of the interface techniques used for data input such as handwriting recognition of small character set languages are very slow when used for large character set languages.

Therefore, because of the increasing use of pen-based electronic input devices, the difficulty of keyboard entry for various languages, including large, complex, character set languages, a need exists for a method and apparatus for character recognition interface of handwritten input for various languages, complex, large character set languages, symbols, and numerals that is quick, accurate, and easy to use.

Brief Description of the Drawings

FIG. 1 Illustrates a perspective view of an apparatus of a preferred embodiment of the present invention.

FIG. 2 Illustrates a perspective view of an alternative apparatus of a preferred embodiment of the present invention.

FIG. 3 Illustrates a preferred method of character recognition interface of the present invention.

FIG. 4 Illustrates a flow diagram of operation of a preferred embodiment of the present invention.

FIG. 5. Illustrates the remaining portion of the flow diagram of operation of FIG. 4.

FIG. 6 Illustrates graphically a preferred method of character recognition interface having a language model phase.

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FIG. 7 Illustrates graphically an alternative preferred method of character recognition interface having a language model phase.

5 FIG. 8 Illustrates a flow diagram of operation detailing a preferred embodiment of character recognition interface having language model phase in accordance with the present invention.

10 FIG. 9 Illustrates the remaining portion of the flow diagram of operation detailing a preferred embodiment of character recognition interface having language model phase in accordance with the present invention illustrated in FIG. 7.

FIG. 10. Illustrates graphically a preferred method of character recognition interface having an editing output buffer.

15 FIG. 11. Illustrates a flow diagram of operation detailing a preferred embodiment of character recognition interface having an editing output buffer in accordance with the present invention.

FIG. 12. Illustrates graphically a preferred method of character recognition interface having an on screen keyboard

20 FIG. 13. Illustrates a flow diagram of operation detailing a preferred embodiment of character recognition interface having an on screen keyboard in accordance with the present invention.

25 FIG. 14. Illustrates graphically a preferred method of character recognition interface having a plurality of user adaptable features

30 FIG. 15. Illustrates a flow diagram of operation detailing a preferred embodiment of character recognition interface having a plurality of user adaptable features in accordance with the present invention.

FIG. 16 Illustrates graphically a preferred method of character recognition interface having a plurality of user adaptable features

35 FIG. 17 Illustrates a flow diagram of operation detailing a preferred embodiment of character recognition interface

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having a plurality of user adaptable features in accordance with the present invention.

FIG. 18 Illustrates an alternative interface in accordance with the present invention.

5 FIG. 19 Illustrates a flow diagram of the alternative interface of FIG. 18 in accordance with a preferred method of the present invention.

10 FIG. 20 Illustrates the remaining portion of the flow diagram in FIG. 19 of the alternative interface of FIG. 18 in accordance with a preferred method of the present invention.

Detailed Description of Preferred Embodiment

15 Generally, the present invention relates to a method and apparatus for character recognition interface of handwritten input; and preferably the present invention relates to a method and apparatus for character recognition interface of
20 handwritten input representing one or more characters selected from a language or compilation of data having a large complex set of characters where each character includes one or
25 more strokes. Generally, an alternative embodiment of the present invention relates to a method and apparatus for character recognition interface of handwritten input representing a graphical image of a signature or other such
30 identifying set of characters.

35 Pursuant to a preferred embodiment of the present invention, candidate characters in support of a handwriting recognition method and apparatus of the present invention are developed through the compilation and statistical analysis of
30 empirical data compiled from hundreds of samples of actual handwritten characters. Candidate characters produced through the development of templates derived from the compilation and statistical analysis of the empirical data are selectable as the recognized character of the handwritten
35 input.

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Referring now to the Figures, FIGS. 1 and 2 illustrate the general operation of a method and apparatus in accordance with a preferred embodiment of the present invention. With reference to FIGS. 1 and 2, examples of pen-based electronic entry devices are illustrated. A personal digital assistant is illustrated in FIG. 1 as generally depicted by the reference numeral 10. The personal digital assistant (10) depicted constitutes a generic representation, typically such devices include a housing (12) and a touch screen (18) upon which input can be handwritten using an appropriate hand manipulated stylus (15). Such devices typically include one or more microprocessors or other digital processing devices. As such, these devices comprise computational platforms that can be readily adapted in accordance with the teachings presented herein. Generally, such devices include one or more application programs, or target applications, operating under control of an operating system comprising instructions for the microprocessor or digital processing device. It should be understood that, while such personal digital assistants comprise a ready platform to accommodate the practice of the applicant's teachings, the teachings presented herein may be practiced in a variety of other operating environments as well. Some examples of such environments include, but are not limited to the following, computers or other electronic entry devices with digitizing screens, or connected to a digitizing input surface, or capable of receiving faxed, scanned, or other electronic input, digital or interactive televisions, modems, telephones, pagers as illustrated in FIG. 2, or other systems with the ability to capture handwritten input and process it. The references illustrated in FIG. 2 refer to substantially similar elements as illustrated in FIG. 1. on an alternative device as illustrated in FIG. 2, i.e., device 20, touch screen 28, housing 22, stylus 25

Referring now to FIGS. 3, 4, and 5, FIG. 3 illustrates a preferred method of character recognition interface of the present invention and FIGS. 4 and 5 illustrate a flow diagram of

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operation corresponding to FIG. 3. Typically a character is input into a device (100) having a memory by means of a stylus (115) or like device on a digitizing surface (117). In accordance with the present invention the input character (102) is mapped to a writing surface (100) or area on the host device (100) through the digitizing surface (117). Various known technology exists for mapping strokes to a selected region of a display area. The input data is compared with recognition data (220). The recognition data is obtained by accessing a recognizer designed to generate a least one most likely candidate character to represent the input character. Generally, the input character is preprocessed into a series of strokes and is processed by the recognizer by comparing the series of strokes with stored recognition data or templates to generate at least one most likely corresponding candidate character. In accordance with the present invention various recognizer and recognition data may be used.

In a preferred embodiment of the present invention the recognizer and recognition data are configured to recognize and provide recognition data for the Chinese characters comprising the sets of GB1 and GB2. Additionally, a preferred recognizer and recognition data for the present invention are configured to recognize and provide recognition data for the Chinese character of GB1 and GB2 and the Taiwanese characters of Big 5-1 and Big 5-2. In a preferred embodiment of the present invention the recognition data generates a graphical image of at least one likely corresponding candidate character (230). If no such image can be generated by this comparison with the recognition data, a graphical image of the unrecognized input character can be stored in memory (232), in the output buffer (116) and sent to an application resident and operating in the device (235), or sent directly to an application. Alternatively the input character may be deleted (238). If at least one likely corresponding candidate character is generated by comparison with the recognition data, typically, a first most

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likely candidate character is displayed (240). This candidate character can be displayed in various areas of the display screen; the writing area (110); the output buffer area (116); the candidate character list area (112); and the language model list area (114). Preferably, the first most likely candidate character is displayed in the output buffer area of the display (240). In accordance with the preferred invention comparing the input character with the stored recognition data can generate at least one likely alternative candidate character in addition to the likely candidate character. Further, in accordance with the preferred embodiment of the present invention, the number of alternative candidate characters generated and displayed can be set by the chosen recognizer; the user; or a default maximum. In a preferred embodiment the default maximum does not exceed ten for the number generated of likely alternative candidate characters. In accordance with the present invention various recognizer and recognition data, or templates, may be used. In a preferred embodiment of the present invention the recognition data generates a graphical image of at least one likely corresponding candidate character and a graphical image of at least one likely alternative candidate character. In a preferred embodiment the likely candidate character and the likely alternative candidate character can be displayed in various areas of the digitizing surface (117) or display screen (118); the writing area (110); the output buffer area (116); the candidate character list area (112); and the language model list area (118). If the most likely candidate character is not an accurate graphical representation of the input character (245), then at least one alternative corresponding candidate character is displayed if one is generated by the comparison of the input data with the recognition data (250). If no alternative correlating candidate character is generated that accurately represents the graphical image of the input character (250) then the user can select from at least one of the following

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options: i) store the unrecognized input character (257) and send to a target application (259), ii) delete input (256), iii) input a new character (258). If an alternative corresponding candidate character exists, preferably the alternative candidate character representing the input is selected (260) replacing the first likely candidate character (265). In accordance with a preferred embodiment the selected alternative corresponding candidate character is stored or displayed in the output buffer display area (270). Preferably the alternative corresponding candidate can be sent directly to a target application, or sent to the target application from the output buffer (275).

Referring now to FIGS. 6, 7, 8, and 9, FIGS. 6 & 7 illustrate alternative preferred methods of character recognition interface of the present invention having language modeling; and FIGS. 8 & 9 illustrate a flow diagram of operation corresponding generally to FIGS. 6 & 7. In accordance with the preferred embodiment of the present invention, the feature, or option, of language modeling may be accessed through a plurality of methods. Language modeling for the purposes of the present invention is the combination of a series or string of characters, word, or symbols that have a likelihood of being associated or correlated to one another to form a phrase, mathematical expression, or other symbolic expression consisting of a plurality of characters. An example of a language model series or string of correlating candidate characters that may be generated from comparison of input data with an English language based recognizer and recognition data is the phrase "Thank God it's Friday". For purposes of the present invention the term character referred to throughout may mean a single letter, a word, one or more ideographic characters, symbols, numbers and the like. Further in accordance with the preferred embodiment of the present invention, the number of series of correlating candidate characters generated and displayed can be set by the chosen recognizer; the user; or a default maximum. In a preferred

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embodiment the default maximum does not exceed ten for the number of series of correlating candidate characters generated to include the likely candidate character or generated to include each alternative likely candidate character.

5 A toolbar language model option as illustrated in FIG. 6 permits the language modeling feature to be activated. Alternatively, the language modeling feature may be displayed in a language modeling area of the display as illustrated in FIG. 7 and be activated from a mouse, stylus or other input device.

10 In accordance with a preferred embodiment of the present invention, the toolbar of the present invention may be selectively enabled and disabled. Additionally, the toolbar may be selectively placed, or displayed, on various areas of the display. Preferably the toolbar is displayed above or below the

15 writing area in some manner.

 When the language modeling feature of the present invention is activated the input character (102) is compared with the recognition data to generate at least one series of a string of correlating candidate characters (330), where such

20 series includes the graphical representation of the character input and a plurality of characters that are commonly combined and include the input character. For example, if a character input is the word "Friday", a language modeling series of correlating candidate characters generated by comparison

25 with the recognition data may generate the phrase "Thank God its Friday". Preferably alternative series of strings of correlated candidate characters are also generated from which selection of an accurate series containing the character input may be made. The term correlated for purposes of the present

30 invention means associated with, commonly combined together, or the like characters commonly associated, or combined together that include the input character.

 In accordance with a preferred embodiment of language modeling of the present invention, an input character is

35 received and mapped into a writing area of a display (310).

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The input character is compared with recognition data (320). If the comparison with the recognition data does not generate at least one likely series of correlating candidate characters (330) various options can be selected including the following: i) store the unrecognized ink of the input character (332) and send to the target application (335), ii) delete the ink of the input character (336), and iii) input a new character (338). In accordance with the present invention ink includes the digitized representation of the input character, the raw input character, regardless if the character is handwritten, scanned, or entered by some other means.

In a preferred embodiment, if the comparison with the recognition data does generate at least one likely series of correlating candidate characters (330) then the first, or most likely, series, or string, of correlating candidate characters is displayed (340). Preferably the series is displayed in a correlating candidate character area of the display. The correlating candidate character area of the display allows the series of correlating candidate characters to be selectively displayed from a language model list area (114) of the display, entered and displayed in the output buffer area (116) of the display, or be displayed by selection of the language model option on the toolbar (108). If the displayed first, or most likely, series of correlating candidate characters displayed accurately represents a string, or phrase of characters containing the graphical representation of the input character (350) then preferably the string is stored in the output buffer (355) and sent to the target application (358). However, if the first, most likely, series of correlating candidate characters does not accurately represent a string, or phrase of characters containing the graphical representation of the input character (350) then at least one alternative series of likely correlating candidate characters is displayed (360). If no alternative series of likely correlating candidate characters is generated by comparison of the input data with the recognition data that

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accurately includes a graphical representation of the input data (370) then various options can be selected including the following: i) store the unrecognized ink of the input character (372) and send to the target application (375), ii) delete the ink of the input character (376), and iii) input a new character (378).

If the comparison with the recognition data does generate at least one likely series of alternative correlating candidate characters which accurately includes a graphical representation of the input data (370) then the string is selected (380) and preferably the string is stored in the output buffer (385) and sent to a target application (390). In accordance with preferred embodiments of the present invention when a language model series of correlating candidate characters is selected, the series can be inserted into an output buffer area of the display (116), sent to a target application, stored a language model area of the display (114), or stored in a language model toolbar option (108) to be retrieved upon selection of the toolbar option.

Referring now to FIGS. 12 & 13, FIG. 12 illustrates graphically a preferred method of character recognition interface having an output buffer which can be edited. FIG. 13 illustrates a flow diagram of operation detailing a preferred embodiment of character recognition interface having an output buffer that can be edited in accordance with the present invention. In accordance with a preferred embodiment of the present invention, a candidate character displayed in the output buffer area (116) of the display maybe edited by selecting the character through various selection means including but not limited to tapping on the character in the output buffer area (116) with a stylus (115) or selecting the character via some other input device such as a mouse. Preferably, once a candidate character has been selected from the output buffer directly for editing, at least one alternative candidate character is displayed, and presented, from which selection for replacement of the candidate character can be

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made. In a preferred embodiment, the alternative candidate character is displayed in an alternative candidate character box (113) as illustrated in FIG. 10. Optionally, the alternative candidate character can be displayed and selected from the alternative candidate character list area (112).

Generally, the editing option occurs after a candidate character has been displayed in the output buffer area (118) of display. Optionally, editing may occur prior to displaying the candidate character in the output buffer area (118) of the display by selecting and displaying on alternative candidate character from the candidate character list area (114) of the display.

In a preferred embodiment the input character (102) is compared to the recognition data (410). Typically, a first candidate character representing the graphical image of the input character is selected or displayed (420). Preferably, the first candidate character is stored in the output buffer (430).

Typically, a candidate character is identified or selected for editing from where it is displayed or stored in the output buffer area of the display (435). As discussed above, various options exist to edit a particular candidate character from the output buffer area of the display (440). Preferably, the candidate character is selected by tapping on the character with a stylus or input device. Upon selection of the candidate character, at least one alternative corresponding candidate character is presented (445) if generated; preferably it is presented in an alternative candidate character box (113) that is displayed in close proximity to the candidate character selected for editing. If at least one alternative candidate character is generated that represents the graphical image of the input data (450) then preferably that alternative candidate character is selected (455). The candidate character that was displayed or stored in the output buffer for editing is replaced by the selected alternative candidate character (460). Preferably, the replacement occurs by simply tapping with a

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stylus or input device on the selected alternative corresponding candidate character displayed in the alternative candidate character box. In accordance with the preferred embodiment, the selected alternative corresponding candidate character is then stored or displayed (465), preferably in the output buffer area of the display and then sent to the target application (470). Optionally, the selected alternative candidate character is sent directly to the target application (470).

If there are no alternative candidate characters that accurately represent the graphical image of the input character are generated than various options are provided. If the first stored, displayed candidate character in the output buffer is a graphic representation of the unrecognized ink of the input character (475) then a preferred editing selection is to delete the first stored candidate character (480). Alternatively, if the first stored candidate character is not a graphic representation of the unrecognized ink of the input character (475) then a preferred editing selection is to retrieve the unrecognized graphic image of the input character (485), replace the first stored candidate character with the unrecognized graphic image of the input character (490), store the unrecognized graphic image of the input character in the output buffer (495); and send the unrecognized graphic image of the input character to the target application (498).

Referring now to FIG 12 and FIG. 13, FIG. 12 illustrates graphically a preferred method of character recognition interface having an on screen keyboard (120). FIG. 13 illustrates a flow diagram of operation detailing a preferred embodiment of character recognition interface having an on screen keyboard in accordance with the present invention. Preferably the on screen keyboard is accessed through selection of the keyboard option on the toolbar (108). Upon selection of the keyboard option, at least one of several various keyboards are generated (530) to select from to receive input. Examples of on screen keyboards available in accordance with

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the preferred embodiments of the present invention include but are not limited to the following: English; numeric; symbols; pin yin; zhuyin; and other non English languages. Once selection of the preferred keyboard is made (540), input characters may be entered onto the display by tapping the graphic representation on the selected keyboard (550). Preferably a display location is selected to map the input character too (560). Typically the input character is stored (570) then mapped to the location selected (580) and sent to the target application. (590)

Referring now to Figs 14 & 15; and FIGS. 16 & 17, FIGS. 14 and 16 illustrate graphically a preferred methods of character recognition interface having pluralities of user adaptable features. FIG. 15, & 17 illustrate a flow diagrams of 14 & 16 respectively, of operations detailing preferred embodiments of character recognition interfaces having pluralities of user adaptable features in accordance with the present invention. In accordance with the preferred embodiments of the present invention, various options are available to be selected through accessing the toolbar. Examples of such options include setup features, including but not limited to the following: pen (input device) (122) width (124), color (126), time out option (128), recognition selection (130), and output code selection (132). In accordance with adapting these options for various user preferences, the setup feature can be accessed through the tool bar (610, 710) and individually selected or selected in pregrouped combinations. The figures 14 through 17 illustrate the pregrouped combinations, but each option may be selected and processed individually in a similar manner. Preferably the desired set up combination is selected (620, 720), the various option or options are generated (630, 730), selection of at least one option is made (640, 740), input is received for the option by means of an input device entering input onto the graphical representation of the option (650, 750). The input is stored

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(660, 760) and the option selection is closed (670, 770). In a preferred embodiment of the present invention, the recognizer option (130) of the setup option (122) permits selection of recognition data (134) that includes the ideographic Chinese characters referred to as GB 1; GB 2, and the Taiwanese characters referred to as Big5-1, and Big5-2. In a preferred embodiment of the present invention, the output code option (132) of the setup option (122) permits selection of the output code (132), wherein selection of the output can be made between the ideographic Chinese characters referred to as GB 1; GB 2, and the Taiwanese characters referred to as Big5-1, and Big5-2. Other languages can be easily adapted for the Recognition and output code options.

Referring now to FIGs. 18, 19, and 20. FIG. 18 illustrates an alternative interface in accordance with the present invention. FIGs. 19 and 20 illustrate a flow diagram of the alternative interface of FIG. 18 in accordance with a preferred method of the present invention.

The alternative preferred embodiment of the present invention illustrated in FIGs. 18, 19, and 20 contemplates that many users will find it convenient to append a signature or other symbols to a document to provide some measure of authentication as to the origin of the document. Accordingly, upon user selection of the signature icon residing in the command area of the primary graphic user interface of FIG. 3, the user is presented with the graphic image shown. A handwritten personal signature or other symbols entered via this interface will be digitized via conventional techniques and the signature data representing the handwritten signature used as selected by the user.

As shown in FIG. 18, the signature graphic user interface comprises a graphical image 1000 having a menu area 1002, a command area (referred to by those skilled in the art as a toolbar) 1004, a signature area 1006, and a status area 1008.

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By comparison of FIG. 18 to FIG. 3, it will be apparent that the toolbar 1004 and status area 1008 contain and convey different information to the user as appropriate given the different functionality offered by the two different graphical user interfaces illustrated in FIG. 3 and FIG. 18.

In the preferred embodiment, the toolbar 1004 of FIG. 18 offers a variety of command functions by presenting a series of icons to provide the functions of:

- 10 New (1010): to open a new signature file;
- Open (1012): to open an existing signature file;
- Save (1014): to save a signature file;
- Copy (1016): to copy of signature file;
- 15 Send (1018): to send the signature file to a selected application;
- Select (1020): to select an application prior to sending the signature file;
- Config (1022): to configure some feature or the like;
- 20 About (1024): to inform the user about some feature or the like.

Using these commands, a user is afforded a simple and efficient interface to enter a personal signature or other symbols to be saved or appended to any of several documents prior to storing, printing, or transmitting the document to a recipient. In the example of FIG. 18, the signature "Earl St. John" 1026 has been handwritten onto the signature area 1006, which can be saved as signature data by selection of the Save icon 1014 or perhaps sent to the application designated (via the Select icon 1020) to receive the recognized handwritten input to be appended thereto as her signature (via the Send icon 1018).

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The operational method for the signature graphical user interface can be readily understood with reference to FIG. 18, FIG. 19, and FIG. 20. Step 1100 of FIG. 19 presents the user with the graphical user interface 1000. Typically, the user
5 would then select to create a new signature document or open an existing one. Decision 1102 determines whether the user has selected the New icon 1010, and if so, creates a new signature file (step 1104) so that the user can handwrite a signature or other symbols in the signature area 1006 of the
10 graphical user interface 1000. Conversely, if the user selects the Open icon 1012, decision 1106 causes step 1108 to present a list of existing signature files to the user for his or her selection and opens the selected signature file (step 1110).

After a new signature file as been created or an existing
15 signature file opened, the user may elect to save the file by selecting the Save icon 1014. Decision 1112 detects the user's selection of the Save icon and causes the currently active signature file to be saved into memory (step 1114) and before returning to await the next user command. In a similar
20 manner, the user's selection of the Copy icon 1016 is detected by decision 1116 which causes step 1118 to copy the information representing whatever handwritten input has been entered in the signature area 1006 to be electronically copied into memory (commonly referred to as scratchpad memory) as
25 signature data. In this way, the user may copy the signature data into other signature files or other applications.

The signature method of the present invention continues in FIG. 20, where decision 1200 determines whether the user has selected the Send icon 1018 causing the signature data to
30 be sent to a user selected application (step 1202). To select a target application to receive the signature data, the user touches the stylus on the Select icon 1020, which is detected by decision 1204, and causes a list of potential applications to be presented to the user (step 1204), and may include a default
35 selection of the application selected by the user to receive the

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recognized handwritten input. After user selection of the intended application, step 1208 stores information enabling the signature data to be sent to the correct application upon the user's next selection of the Send icon 1016.

5 The present invention offers the user a great deal of signature or other authentication information via the ConFIG. icon 1022. Decision 1210 detects the user's selection of the ConFIG. icon 1022 and allows the user to configure (step 1212) several parameters such as the color and line width (referred
10 to as the ink by those skilled in the art) of the presentation of the handwritten signature 1026.

 The final command in the preferred embodiment of the present invention is the About icon 1024. Upon the user's selection of the About icon 1024, decision 1214 causes
15 information to be presented to the user for his or her information (step 1216). This information may remain displayed until the user closes the information window, or may be presented for a time period after which the information window automatically closes and the signature method of the
20 present invention awaits the next user instruction.

 Those skilled in the art will find many embodiments of the present invention to be useful. One obvious advantage is ease of data, or text, input over traditional key-board entry methods, including the obvious advantage of the ease of entry
25 of scanned or "off-line" handwritten input into printed data, or text. Another obvious advantage is recognition of handwritten input where the input represents a single character, data point, or other unitary identifying graphically representation, that is a subset of a large complex set of characters, data points, or other
30 graphical representation.

 It will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than the preferred forms particularly set out and described above. Accordingly, it
35 is intended by the appended claims to cover all modifications of

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the present invention that fall within the true spirit and scope of the present invention and its equivalents.

What is claimed is:

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1. A method comprising the steps of:
 - comparing input with recognition data stored in a memory to generate at least one candidate character having a likelihood of corresponding to said input;
 - 5 displaying a graphical image having therein a graphically writing area from which the input data is accepted and a separate output area for presenting at least one candidate character; and
 - storing in a memory at least one candidate character for latter retrieval from said memory.
- 10 2. A method of comprising the steps of:
 - receiving input from a writing area of a display;
 - generating a plurality of candidate characters
 - 15 having a statistical likelihood of corresponding to said input by comparison of said input with recognition data stored in a memory;
 - displaying said plurality of candidate characters in a candidate list area of said display;
 - 20 selecting a most likely candidate character from the plurality of candidate characters;
 - displaying the most likely candidate character in an output buffer area of said display.
- 25 3. The method of claim 2, further comprising the step of:
 - storing the most likely candidate character in a memory.
- 30 4. A method comprising the steps of:
 - receiving input data from a writing area of a display
 - comparing the input data with character recognition data to identify at least one likely candidate character likely to represent the input data, and identifying at least one

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alternative candidate character likely to represent the input data;

displaying the at least one likely candidate character in an output buffer area of said display; and

5 displaying the at least one alternative candidate character in a candidate list area of said display.

5. The method of claim 4, further comprising the step of:
storing the at least one likely candidate character in
10 a memory.

6. The method of claim 4, further comprising the step of:
storing the at least one alternative candidate character in a memory.

15 7. The method of Claim 4, further comprising the steps of:
replacing the at least one likely candidate character in the output buffer and stored in the memory with one of the alternative candidate characters selected from the at least one alternative candidate characters; and
20 displaying the selected alternative candidate character in the output buffer.

8. The method of Claim 4, wherein the at least one alternative candidate character can be accessed, displayed, and
25 selected from, by selecting the at least one likely candidate character displayed in the output buffer for replacement, where the at least one likely candidate character and the at least one alternative candidate character were generated to represent the same input data.

30 9. A method comprising the steps of:
comparing input data received from a writing area of a display with character recognition data;
identifying at least one likely candidate character
35 representing a word likely to represent the input data;

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identifying at least one alternative candidate character representing an alternative word likely to represent the input data;

5 identifying at least one series of correlating candidate characters for the at least one likely candidate character and for each alternative candidate character, each series of correlating candidate characters representing a series of correlating words likely to include a word representing the input data;

10 displaying the at least one likely candidate character in an output buffer area of said display;

displaying the each alternative candidate character in a candidate list area of said display; and

15 displaying the at least one series of correlating candidate characters in a correlating candidate characters area of the display.

10. The method of claim 9, further comprising the steps of:
20 storing the at least one likely candidate character in a memory.

11. The method of claim 9, further comprising the steps of:
storing the plurality of alternative candidate characters in a memory.

25 12. The method of claim 9, further comprising the steps of:
storing the at least one series of correlating candidate characters in a memory.

13. The method of claim 9, further comprising the steps of:
30 replacing the at least one likely candidate character in the output buffer with one of the likely series of correlating candidate characters selected from the at least one likely series of correlating candidate characters displayed in the correlating candidate character area of the display; and
35 displaying the selected likely series of candidate characters in the output buffer.

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14. The method of claim 13, wherein the correlating candidate characters area of the display is a language model area and the likely series of correlating candidate characters is
5 selected from the at least one likely series of correlating candidate characters displayed in the language model area.

15. The method of claim 13, wherein the correlating candidate characters area of the display is displayed through
10 selection of a toolbar language model option and the likely series of correlating candidate characters is selected from the at least one likely series of correlating candidate characters displayed by selecting the tool bar language model option.

15 16. The method of claim 9, further comprising the steps of:
replacing the at least one likely candidate character displayed in the output buffer with one of the alternative candidate characters selected from the at least one alternative candidate characters;

20 displaying the selected alternative candidate character in the output buffer;
replacing the alternative candidate character displayed in the output buffer and stored in the memory with one of the likely series of correlating candidate characters
25 selected from the at least one likely series of correlating candidate characters; and

displaying the selected likely series of correlating candidate characters in the output buffer.

30 17. The method of claim 16, wherein the correlating candidate characters area of the display is displayed in a language model area and the likely series of correlating candidate characters is selected from the at least one likely series of correlating candidate characters displayed in the
35 language model area.

- 25 -

18. The method of claim 16, wherein the correlating candidate characters area of the display is displayed through selection of a toolbar language model option and the likely series of correlating candidate characters is selected from the at least one likely series of correlating candidate characters displayed by selecting the tool bar language model option.

19. A method comprising the steps of:
10 comparing input data received into a writing area of a display with character recognition data
 identifying at least one likely candidate character representing a word likely to represent the input data;
 identifying at least one likely series of correlating candidate characters for the at least one likely candidate character representing a series of correlated words likely to include a word representing the input data;
15 displaying the at least one likely candidate character in an output buffer area of said display; and
20 displaying the at least one likely series of correlating candidate characters in a correlating candidate area of the display.

20. The method of claim 19, further comprising the steps of:
25 storing the at least one likely candidate character in a memory.

21. The method of claim 19, further comprising the steps of:
 storing the at least one likely series of correlating candidate characters in a memory.
30

22. The method of claim 19, further comprising the steps of:
 replacing the at least one likely candidate character in the output buffer and stored in the memory with one of the likely series of correlating candidate characters selected from
35

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the at least one likely series of correlating candidate characters
; and

displaying the selected likely series of candidate
characters in the output buffer.

5

23. The method of 19., wherein the correlating candidate
characters area of the display is displayed in a language model
area and the likely series of correlating candidate characters is
selected from the at least one likely series of correlating
10 candidate characters displayed in the language model area.

:

24. The method of claim 19, wherein the correlating
candidate characters area of the display is displayed through
selection of a toolbar language model option and the likely
15 series of correlating candidate characters is selected from the at
least one likely series of correlating candidate characters
displayed by selecting the tool bar language model option.

25. A method comprising the steps of:
20 comparing input data received from a writing area
of a display with character recognition data;
identifying at least one series of correlating
candidate characters representing a series of correlated words
likely to include a word representing the input data; and
25 displaying the at least one series of correlating
candidate characters in an area of the display.

26. The method of claim 25, further comprising the steps of:
storing the at least one series of correlating
candidate characters in a memory.

30

27. The method of claim 25, wherein the at least one series of
correlating candidate characters is displayed in an output
buffer area of the display.

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28. The method of claim 25, wherein the at least one series of correlating candidate characters is displayed in language model list area of the display.

- 5 29. A method comprising the steps of:
comparing input data received into a writing area of
a display with character recognition data;
identifying at least one likely series of correlating
candidate characters representing a series of correlated words
10 likely to include a word representing the input data;
identifying at least one alternative series of
correlating candidate characters representing an alternative
series of correlated words likely to include a word representing
the input data;
15 displaying the at least one series of correlating
candidate characters in an output buffer area of the display;
and
displaying the at least one alternative series of
correlating candidate characters in a language model area of
20 the display.

30. The method of claim 29, further comprising the steps of:
storing the at least one series of correlating
candidate characters in a memory.

- 25 31. The method of claim 29, further comprising the steps of:
storing the at least one alternative series of
correlating candidate characters in a memory.

- 30 32. The method of claim 29, further comprising the steps of:
replacing the at least one likely series of correlating
candidate characters in the output buffer and stored in the
memory with one of the alternative series of correlating
candidate characters selected from the at least one alternative
series of correlating candidate characters ; and

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displaying the selected alternative series of candidate characters in the output buffer.

33. A method, comprising the steps of:

5 displaying a graphical image having an area thereof for receiving handwritten characters for comparison with recognition data to provide candidate recognition information comprising at least one likely candidate character presented in an output area of the graphical image, at least one alternate
10 candidate character presented in a candidate character area of the graphical image, and at least one series of correlating candidate characters representing at least one set of words or phrases likely to be associated with the at least one likely candidate character, the series of correlating candidate
15 characters presented in the correlating candidate character area of the graphical image; and

processing user instructions to replace the at least one likely candidate character presented in the output area with a candidate character selected from the at least one alternative
20 candidate characters presented in the candidate character area of the graphical image, and replacing the at least one series of correlating candidate characters in the correlating candidate character area with a second series of correlating candidate characters likely to be associated with the candidate character
25 selected from the at least one alternative candidate characters.

34. The method of claim 4, further comprising the steps of:

providing a tool bar that is movable about a display area, said tool bar having a plurality of options from which to
30 select including but not limited to the following: language model display; on screen keyboard options; setup options; status bar options; and copy, send, clear, and help options.

35. The method of claim 4, wherein the toolbar may be
35 disabled.

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36. The method of claim 34, wherein said on screen keyboard is displayed when the toolbar on screen option is selected; said on screen keyboard having a plurality keyboards from which to
5 select and enter input data including but not limited to the following: English; numeric; symbol; pin yin; and shuyin.

36. The method of claim 34, wherein each of the plurality of options of the tool bar has a prestored default setting; each of
10 said default settings is configured to be replaceable with a preferred option input setting.

37. The method of claim 36, wherein the preferred option input setting replaces the prestored default setting and is then
15 stored as the prestored default setting.

38. A device, comprising:
a digitizing display, said display having an input display area, an output buffer display area, a candidate list display
20 area, and language model display area, said digitizing display adapted to receive into the input display area handwritten input:

display processing circuitry for presenting a graphical image on the digitizing display representing the handwritten
25 input, and for processing the handwritten input to provide handwritten information data;

a memory having at least recognition data stored therein;
digital processing circuitry for comparing the handwritten information data with the recognition data to provide to the
30 display processing circuitry candidate recognition information including at least one likely candidate character representing at least one likely word corresponding to the handwritten input;
at least one likely alternative candidate character representing at least one likely alternative word corresponding to the
35 handwritten character, and at least one series of correlating

- 30 -

candidate characters representing a series of correlating words that include at least one likely word representing the handwritten input;

5 wherein the display circuitry displays for user interaction in an output buffer area the at least one likely candidate character, and displays in a candidate list area the at least one likely alternative candidate character, and displays in the language model display area at least one series of correlating candidate characters.

10

39. A device, comprising:

a digitizing display for digitizing into a plurality of graphical images that represent input data and for displaying the graphical images, said plurality of graphical images including at least one likely candidate character displayed in one portion of the digitizing display, at least one likely alternative candidate character displayed in a second portion of the digitizing display, and at least one series of correlating candidate characters displayed in a third portion of the digitizing display;

20

a memory having at least recognition data stored therein; digital processing circuitry for processing input data to provide candidate character information for comparison with the recognition data to provide said plurality of graphical images that represents the input data for user interaction.

25

40. A device, comprising:

a digitizing display for presenting a graphical image on the digitizing display and for displaying a likely candidate character in one portion of the graphical image, other candidate recognition information in a second portion of the graphical image, and characters or words that may be likely characters or words to associate with the likely candidate character in a third portion of the graphical image;

30

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display processing circuitry for displaying the graphical image on the digitizing display and for processing characters handwritten within a writing area of the graphical image to provide information representing the handwritten characters;

5 a memory having instructions and recognition data stored therein;

digital processing circuitry including a digital processing device for processing the instructions stored in the memory to compare the information representing the handwritten
10 characters with the recognition data to provide candidate recognition information including at least the likely candidate character to the display processing circuitry, and for processing the instructions to generate the characters or words that may be likely characters or words to associate with the likely
15 candidate character.

41. A device, comprising:

a digitizing display;

a memory having instructions and recognition data stored
20 therein;

digital processing circuitry including a programmable digital processing device capable of performing a plurality of functions by processing at least portions of the instructions stored in the memory, the plurality of functions comprising;

25 displaying a graphical image on the digitizing display;

processing characters handwritten within a writing area of the graphical image to provide information representing the handwritten characters;

30 comparing the information representing the handwritten characters with the recognition data stored in the memory to provide candidate recognition information including at least a likely candidate character;

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generating characters or words that may be likely characters or words to associate with the likely candidate character; and

5 displaying the likely candidate character in one portion of the graphical image, other candidate recognition information in a second portion of the graphical image, and characters or words that may be likely characters or words to associate with the likely candidate character in a third portion of the graphical image.

10

42. A device, comprising:
a digitizing display;
a memory having instructions and recognition data stored therein;

15

digital processing circuitry including a programmable digital processing device capable of emulating the functionality of a plurality of circuits by processing at least portions of the instructions stored in the memory, the plurality of circuits comprising;

20

display processing circuitry for displaying a graphical image on the digitizing display;

digitizing circuitry for processing characters handwritten within a writing area of the graphical image to provide information representing the handwritten characters;

25

comparison circuitry for comparing the information representing the handwritten characters with the recognition data stored in the memory to provide candidate recognition information including at least a likely candidate character to the display processing circuitry;

30

circuitry to generate characters or words that may be likely characters or words to associate with the likely candidate character; and

graphics generation circuitry for generating the graphical image and for displaying a likely candidate character
35 in one portion of the graphical image, other candidate

- 33 -

recognition information in a second portion of the graphical image, and characters or words that may be likely characters or words to associate with the likely candidate character in a third portion of the graphical image.

5

43. A device, comprising:

a digitizing display;

a memory having an operating system and application programs stored therein, and including handwriting recognition

10

instructions and recognition data;

digital processing circuitry including a programmable digital processing device capable of functional emulation of a plurality of circuits by processing the handwriting recognition instructions in accordance with the operating system, the

15

plurality of circuits comprising;

display processing circuitry for displaying a graphical image on the digitizing display;

digitizing circuitry for processing characters handwritten within a writing area of the graphical image to provide information representing the handwritten characters;

20

comparison circuitry for comparing the information representing the handwritten characters with the recognition data stored in the memory to provide candidate recognition information including at least a likely candidate character to

25

the display processing circuitry;

circuitry to generate characters or words that may be likely characters or words to associate with the likely candidate character; and

graphics generation circuitry for generating the graphical image and for displaying a likely candidate character in one portion of the graphical image, other candidate recognition information in a second portion of the graphical image, and characters or words that may be likely characters or words to associate with the likely candidate character in a third

35

portion of the graphical image.

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44. A device, comprising:
- a digitizing display;
 - a memory having an operating system and application
- 5 programs stored therein, and including handwriting recognition instructions and recognition data;
- digital processing circuitry including a programmable
- 10 digital processing device capable of functional emulation of a plurality of circuits by processing the handwriting recognition instructions in accordance with the operating system, the plurality of circuits comprising:
- display processing circuitry for displaying a
- graphical image on the digitizing display;
- digitizing circuitry for processing characters
- 15 handwritten within a writing area of the graphical image to provide information representing the handwritten characters;
- comparison circuitry for comparing the information
- representing the handwritten characters with the recognition data stored in the memory to provide candidate recognition
- 20 information including at least a likely candidate character to the display processing circuitry;
- circuitry to generate characters or words that may
- be likely characters or words to associate with the likely candidate character;
- 25 graphics generation circuitry for generating the graphical image and for displaying a likely candidate character in a first portion of the graphical image, other candidate recognition information in a second portion of the graphical image, and characters or words that may be likely characters or
- 30 words to associate with the likely candidate character in a third portion of the graphical image;
- the plurality of circuits further comprising at least one circuit selected from the group of circuits consisting of:
- character editing circuitry capable of replacing the
- 35 likely candidate character with selected candidate character

- 35 -

information from the second portion of the graphical image responsive to user instructions to present a corrected recognition character in the first portion of the graphical image;

5 phrase editing circuitry capable of presenting selected characters or words from the third portion of the digitizing display in the first portion of the graphic image responsive to user instructions;

10 data routing circuitry operating in accordance with the operating system for routing all characters presented in the first portion of the graphic image to at least one of the application programs responsive to user instructions selected in a command portion of the graphical image.

15 45. The device of claim 10, wherein the circuitry to generate characters or words that may be likely characters or words to associate with the likely candidate character further generates a second set of characters or words that may be likely characters or words to associate with the corrected candidate character provided by the character editing circuitry, whereby
20 the graphics generation circuitry operates to replace the characters or words in the third portion of the graphic image with the second set of character or words.

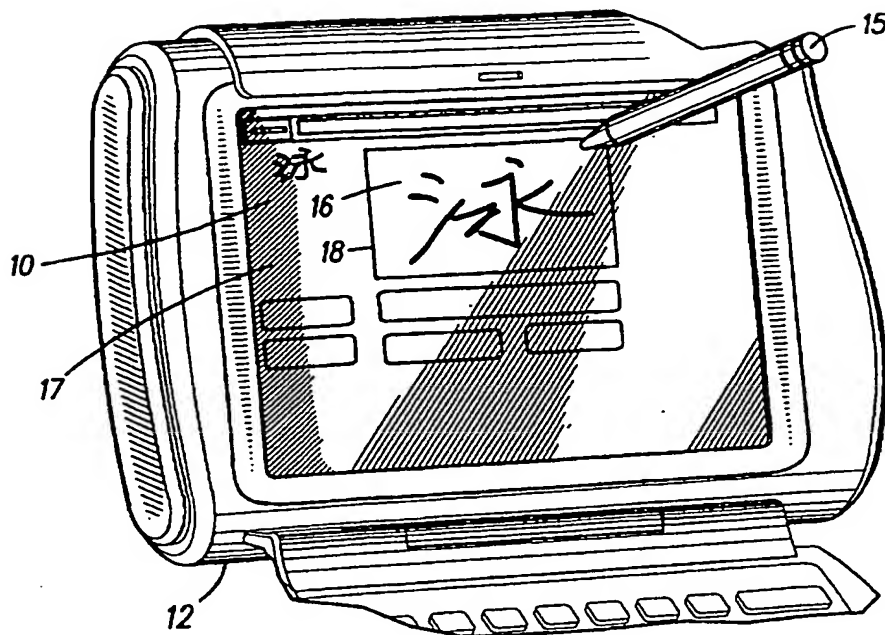


FIG. 1

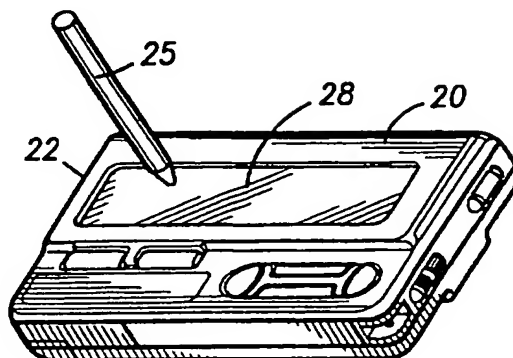


FIG. 2

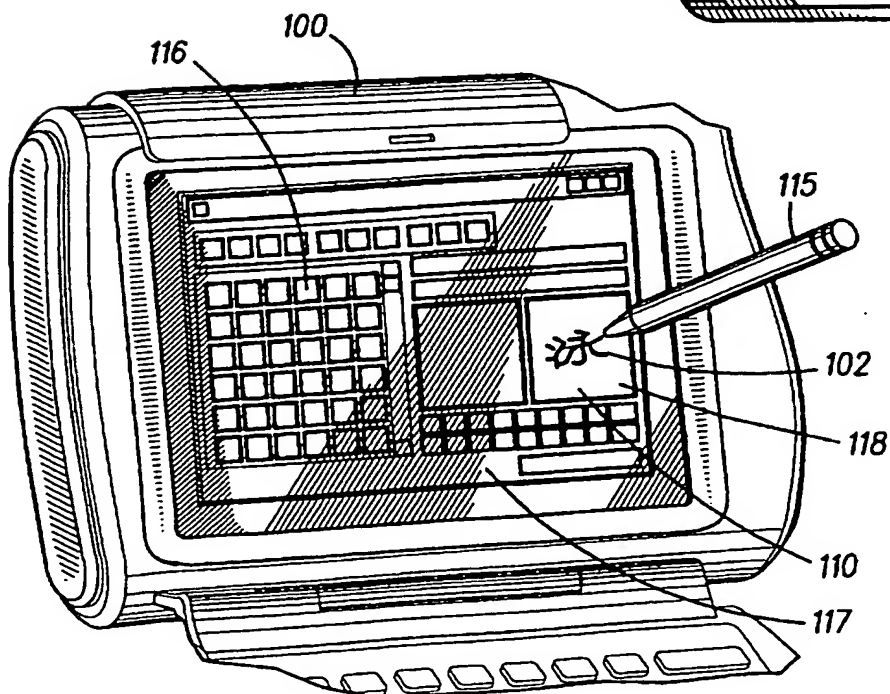


FIG. 3

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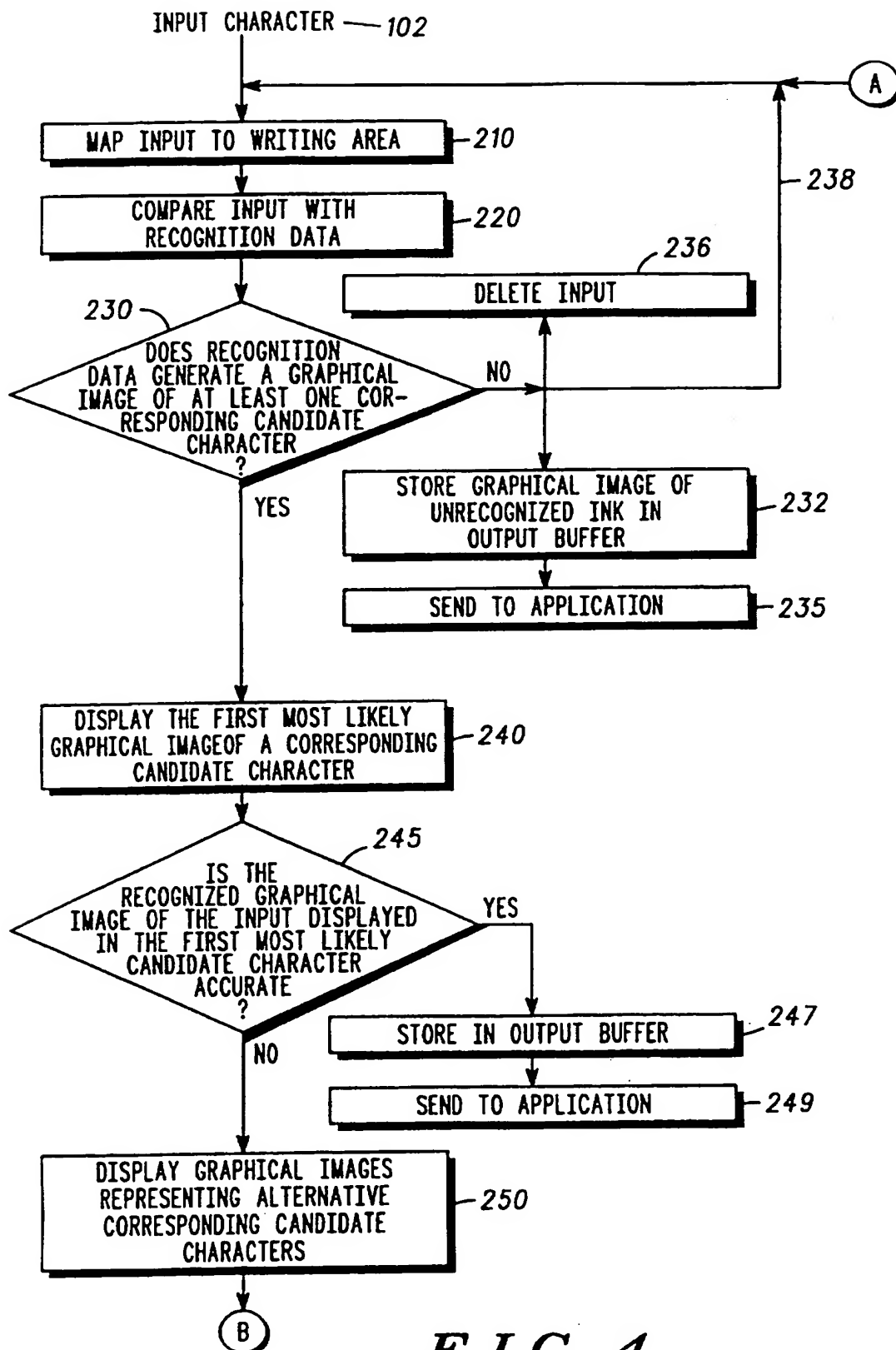
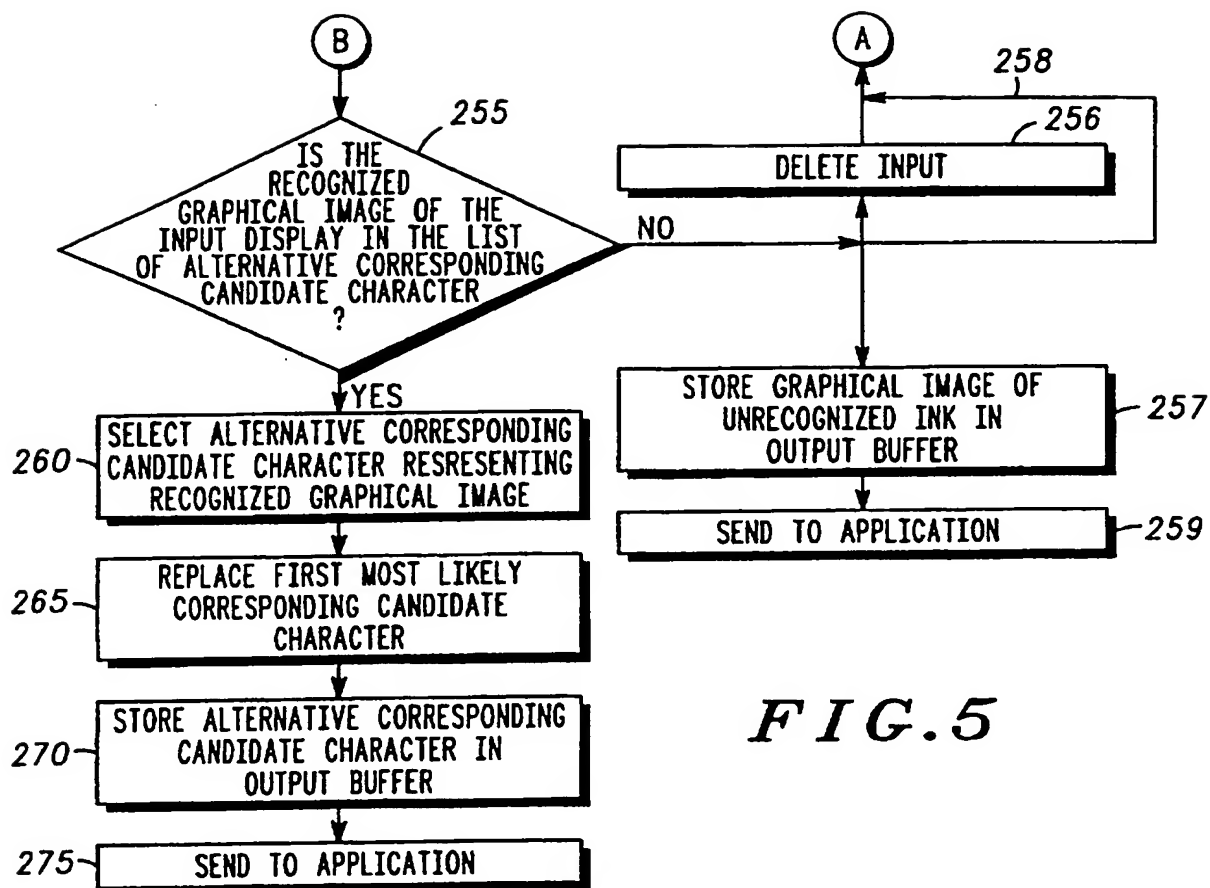
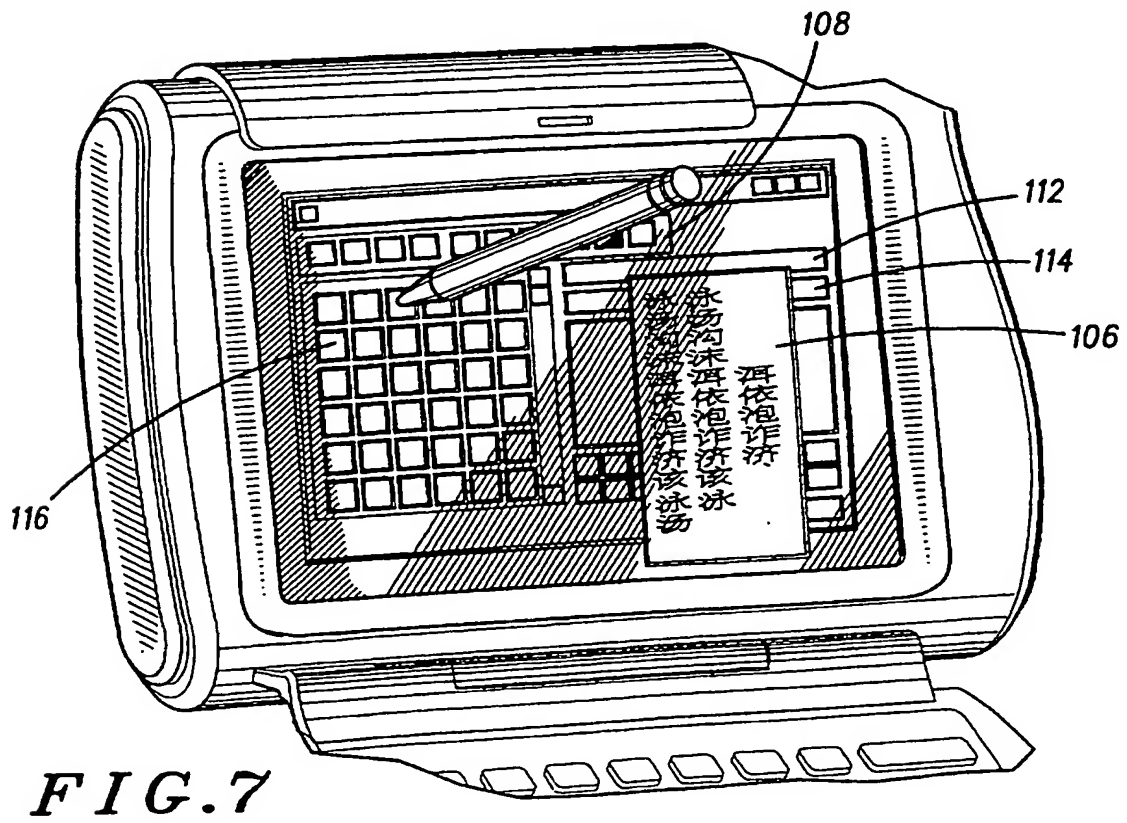
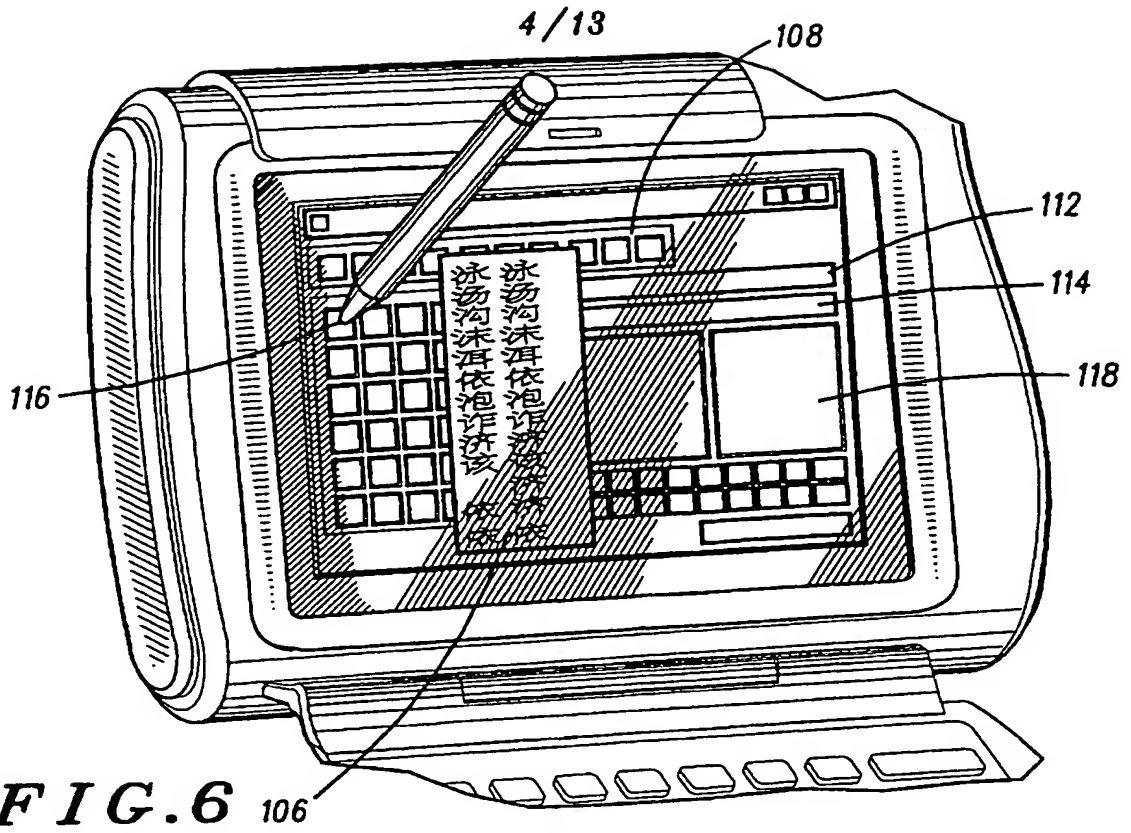


FIG. 4

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*FIG. 5*



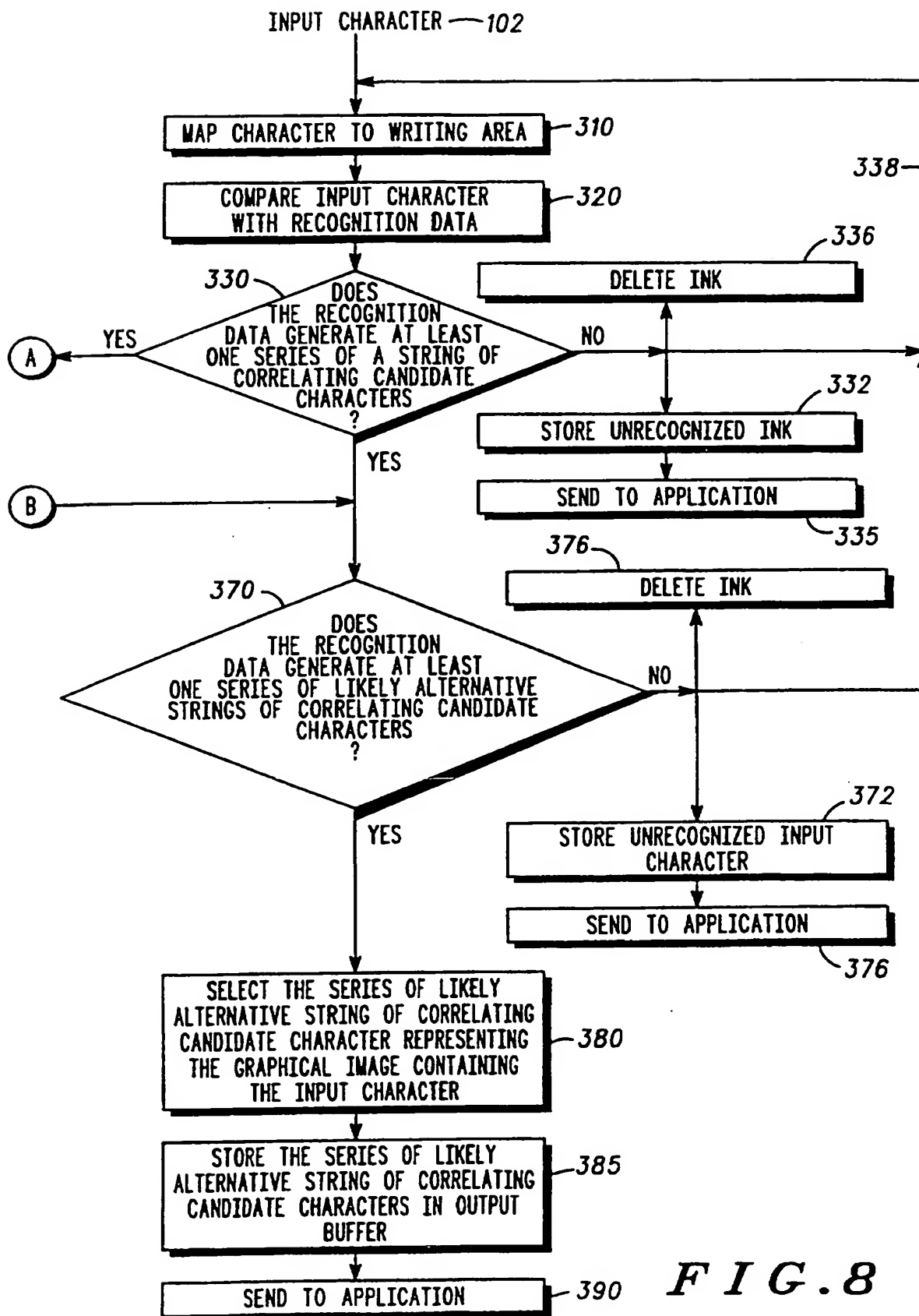
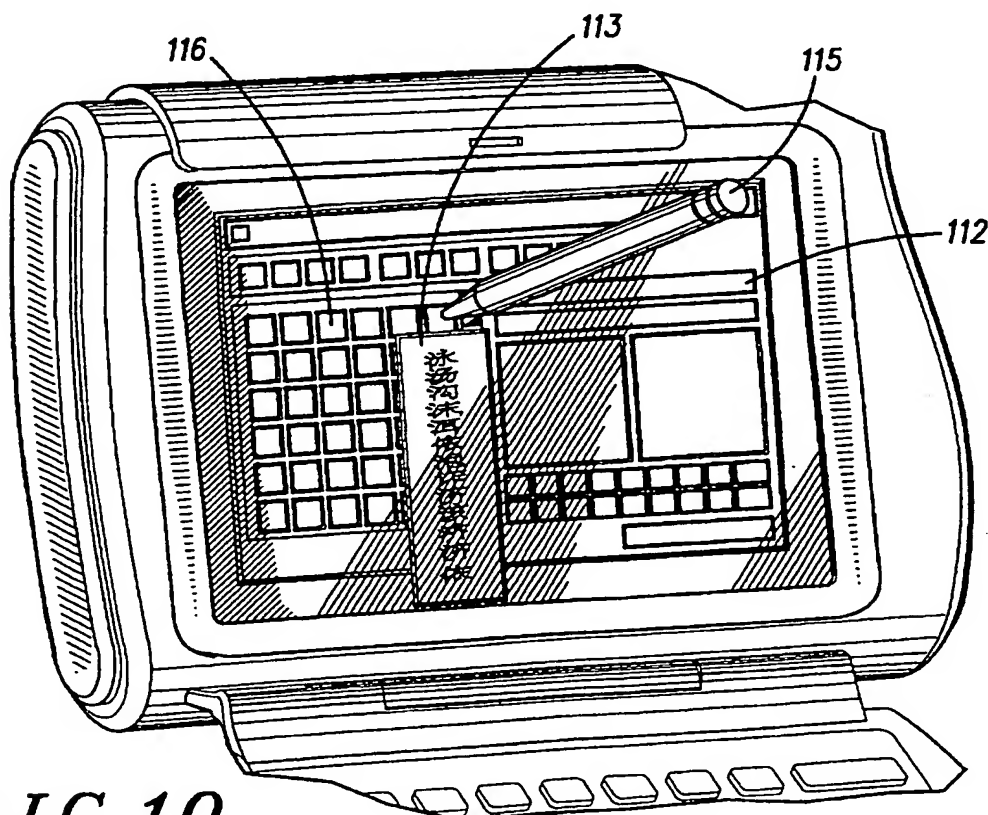
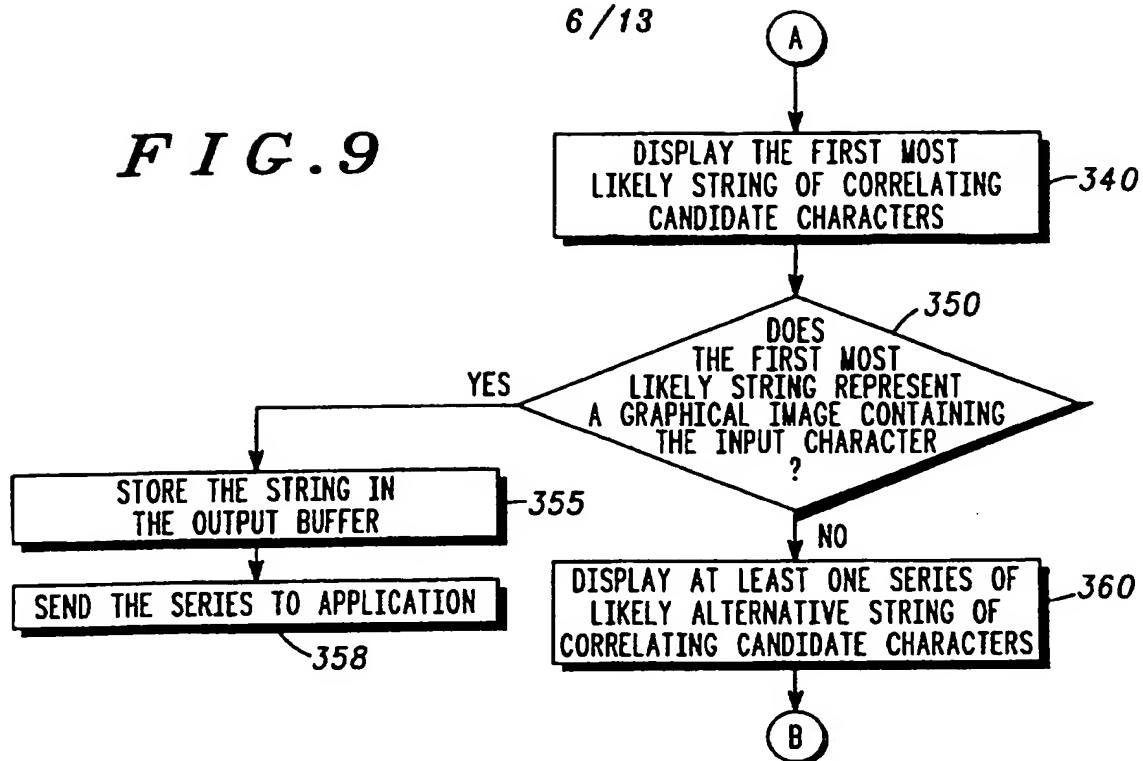


FIG. 8

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FIG. 9**FIG. 10**

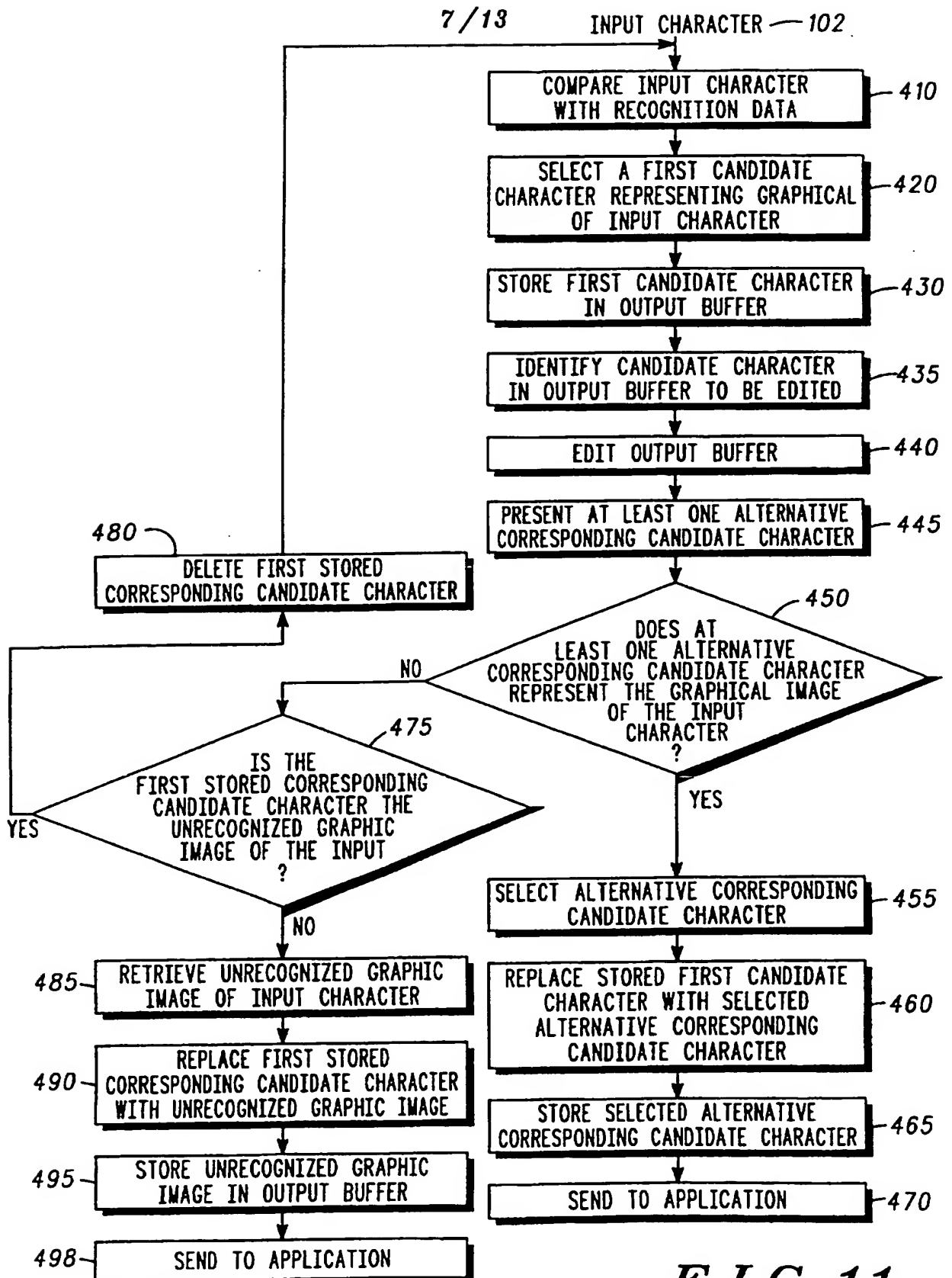
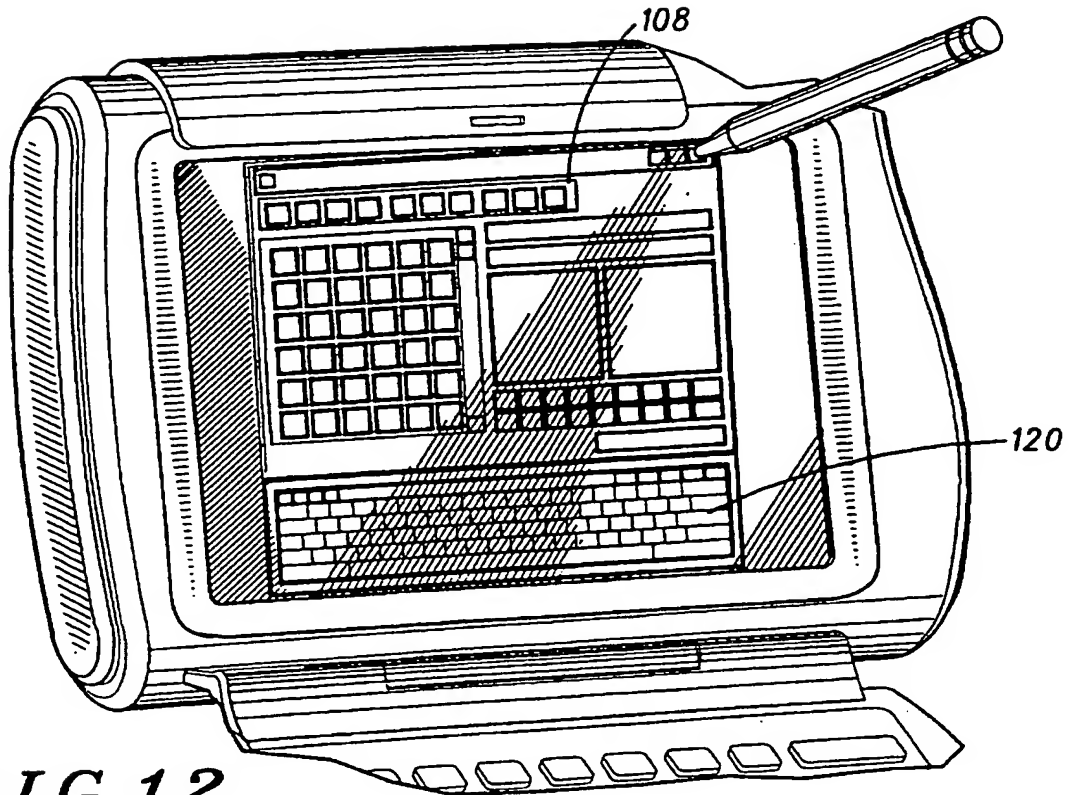
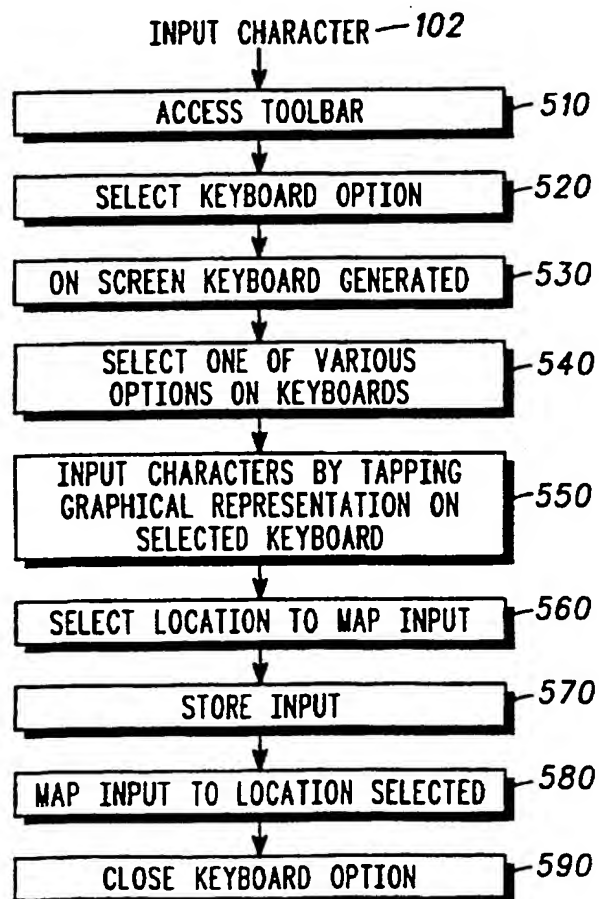
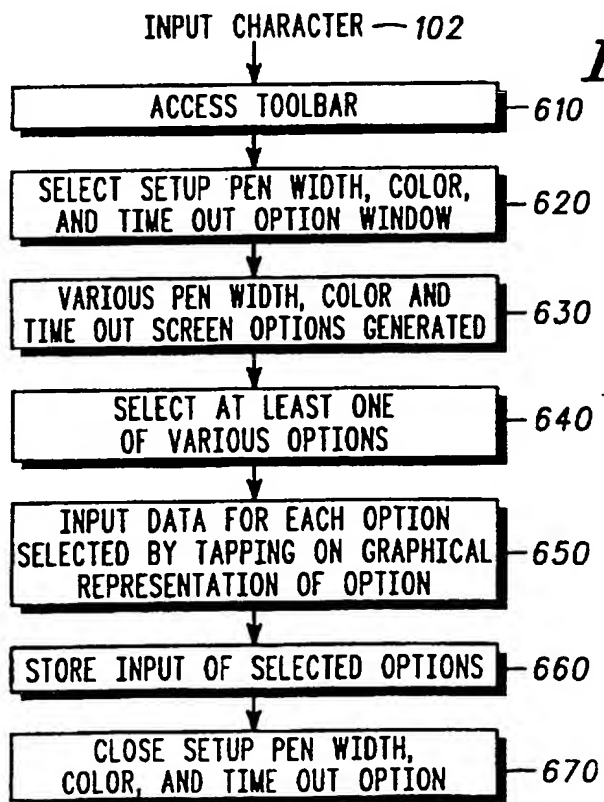
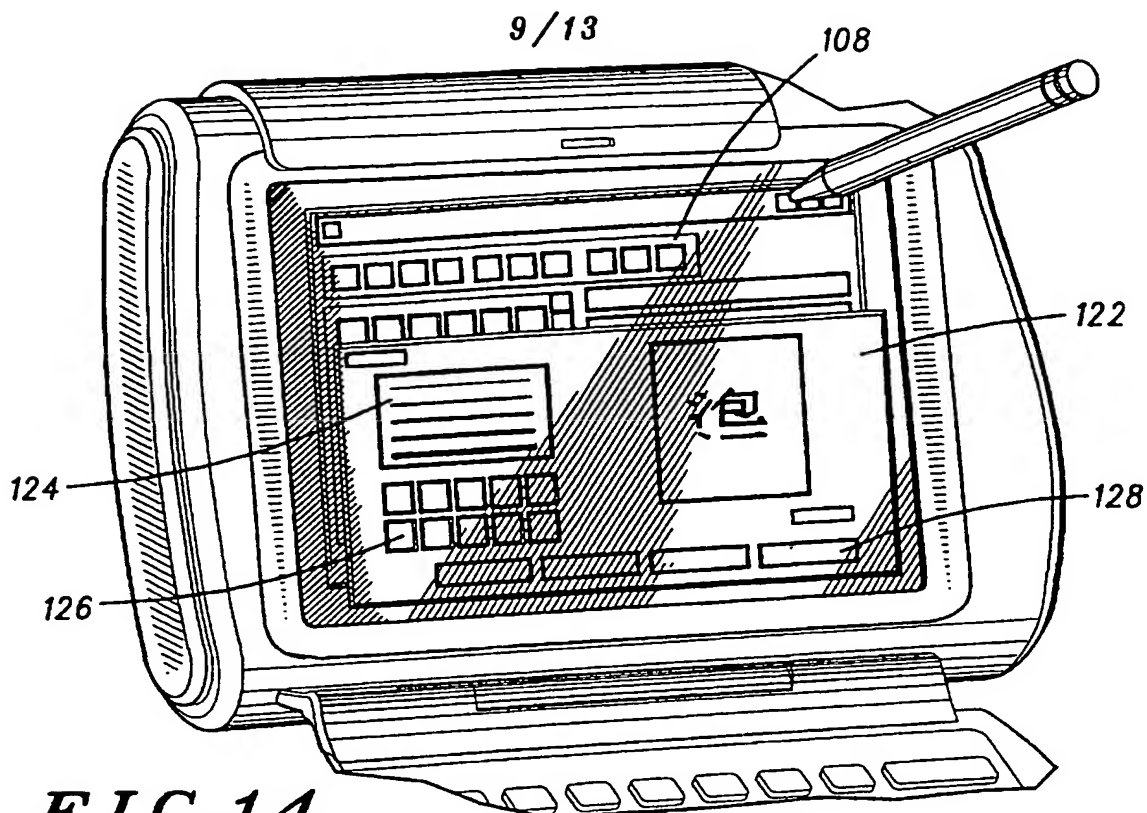


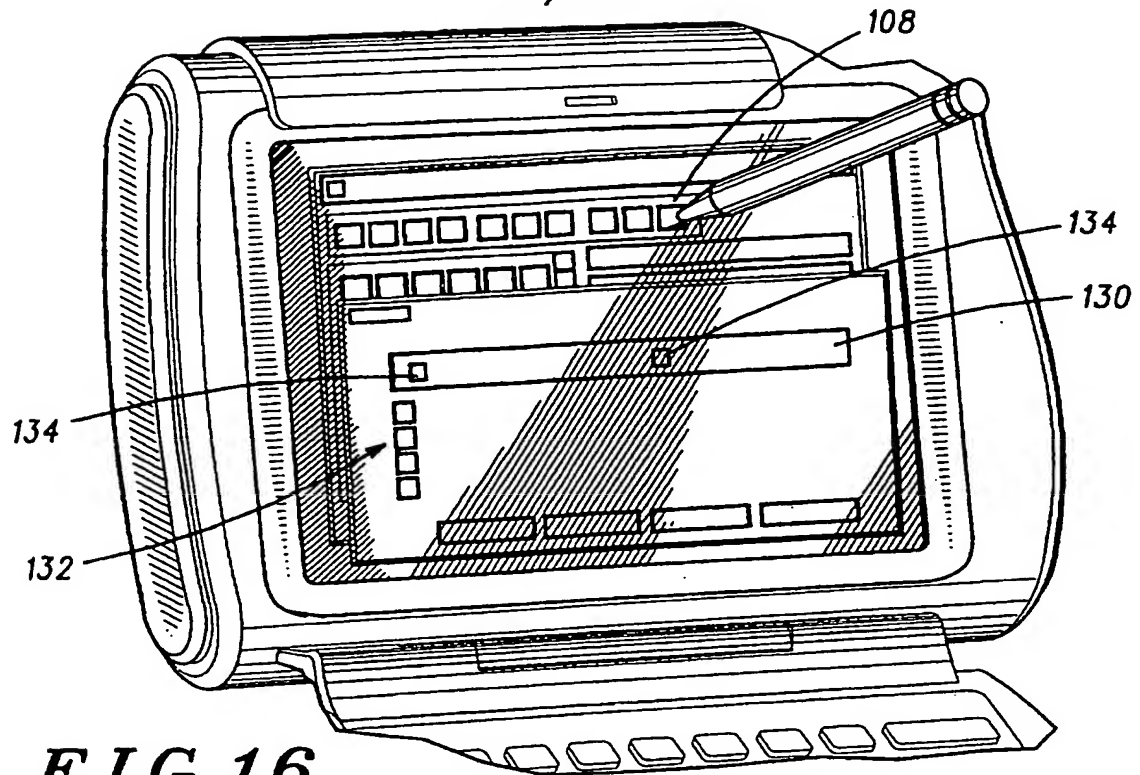
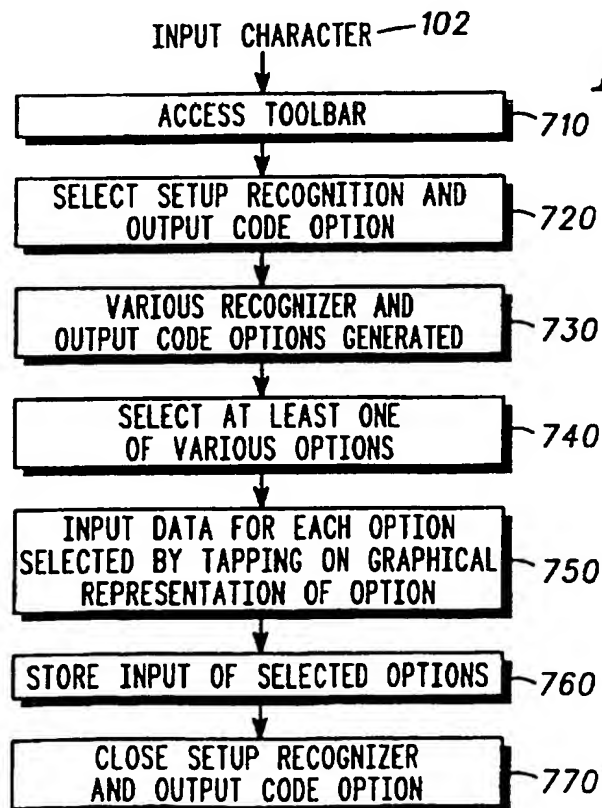
FIG. 11

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**FIG. 12****FIG. 13**



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**FIG. 16****FIG. 17**

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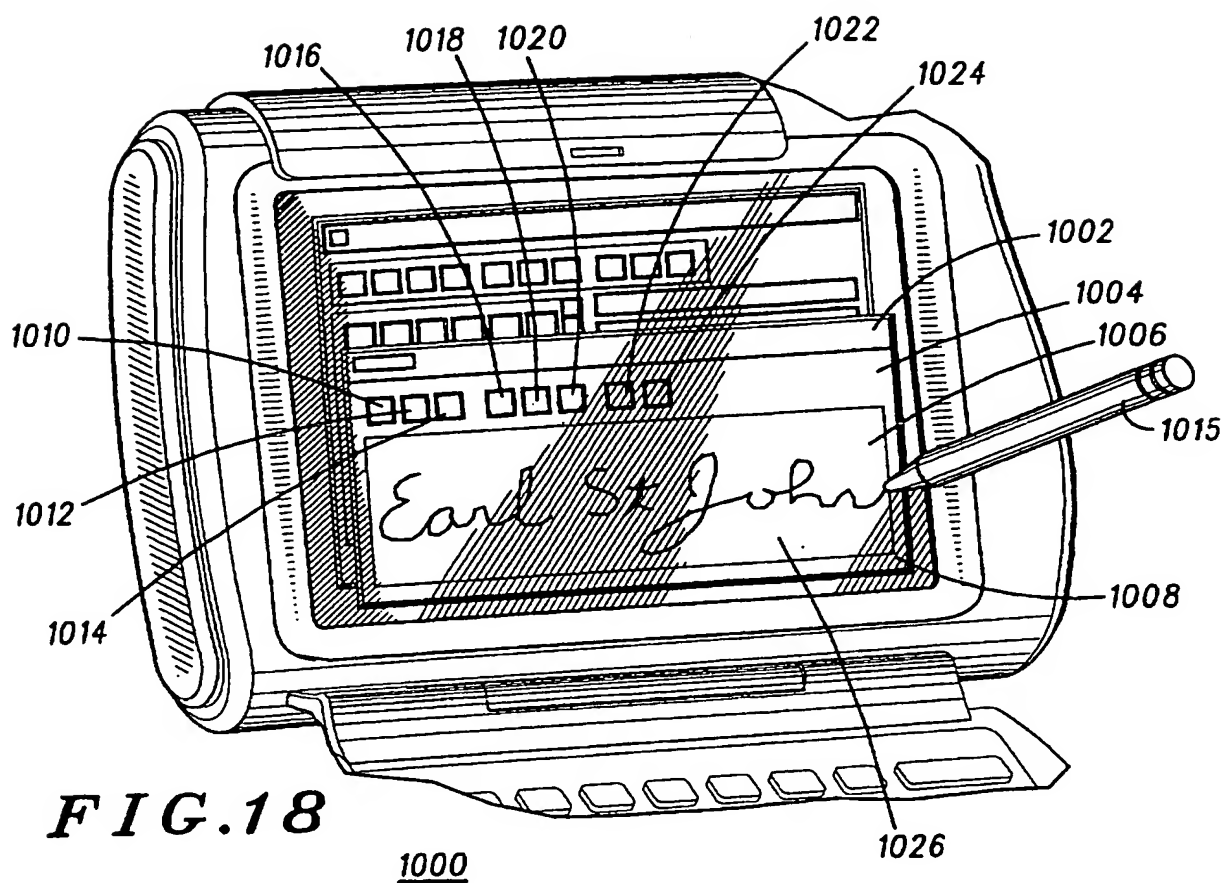
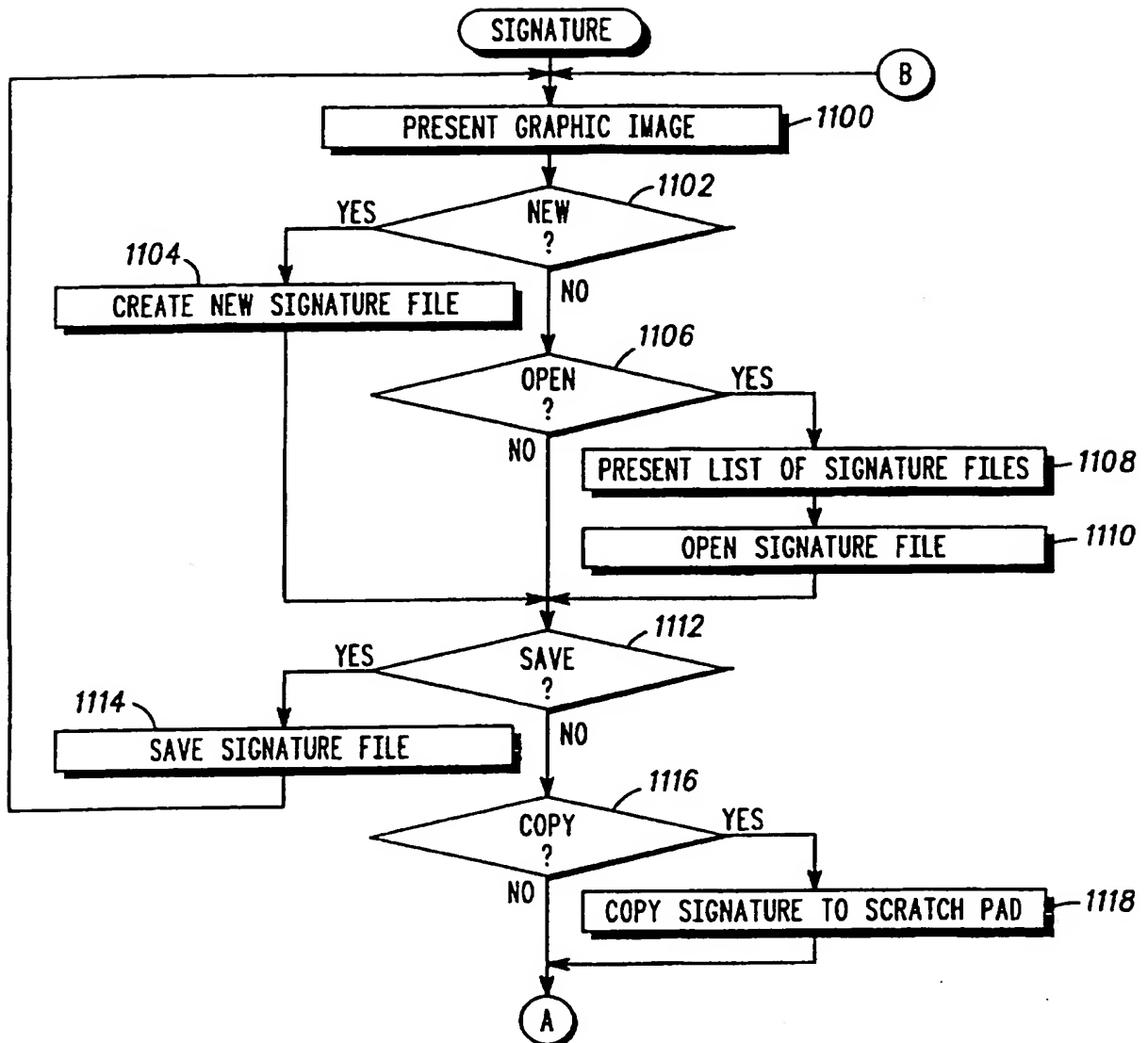


FIG. 18

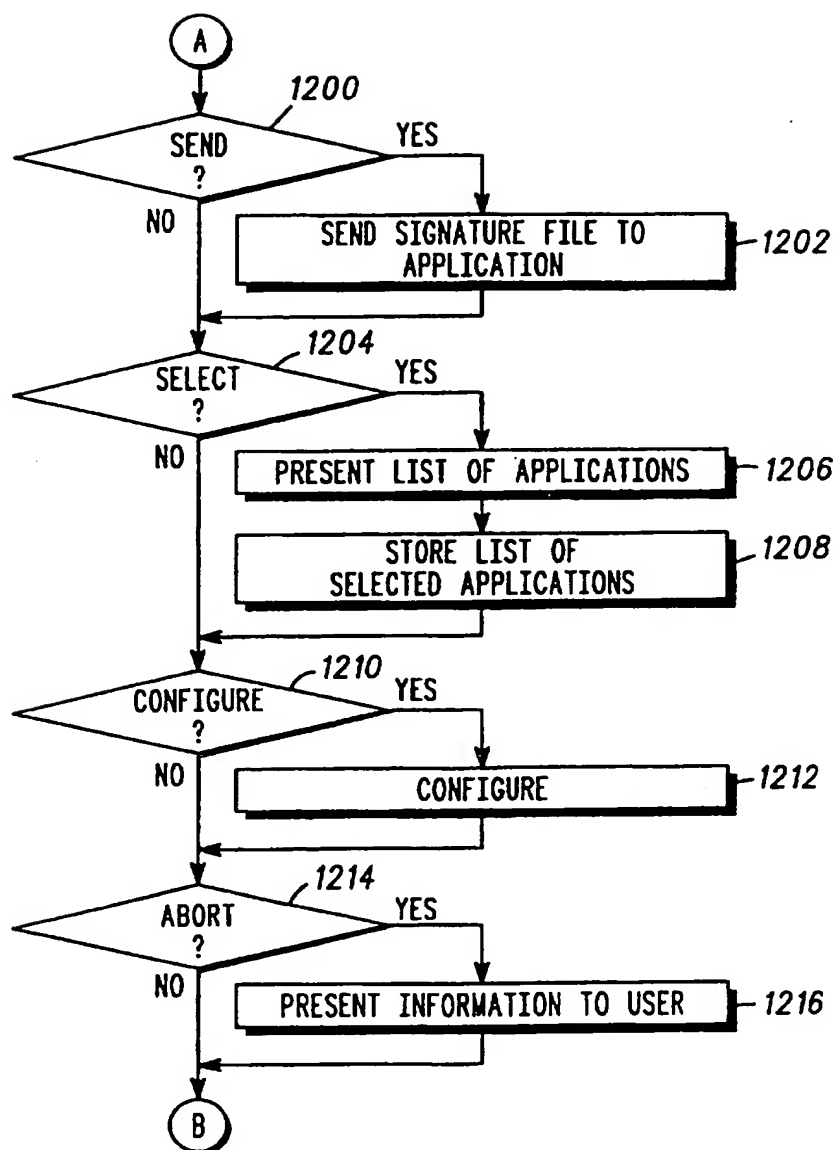
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*FIG. 19*

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**FIG. 20**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/18220

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G06K 9/00, 9/03; G10L 3/02; G06F 15/00

US CL : 382/187, 188, 189, 309; 395/2.6, 149

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 382/187, 188, 189, 309; 395/2.6, 149

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

MAYA ELECTRONIC SEARCH

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5,329,609 (SANADA ET AL) 12 July 1994, Abstract, Figures 1-16, col. 3, lines 7-32, col. 11, lines 10-43.	1-45
A	US, A, 5,020,117 (OOI ET AL) 28 May 1991, Abstract, Figures 1-14.	1-45
X	US, A, 5,410,612 (ARAI ET AL) 25 April 1995, Abstract, Figures 1-5.	1-45
X	US, A, 5,455,901 (FRIEND ET AL) 03 October 1995, Abstract, Figures 1-8.	1-45

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"U" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

19 DECEMBER 1996

Date of mailing of the international search report

11 FEB 1997

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